The REMR *Bulletin*

News from the Repair, Evaluation, Maintenance, and Rehabilitation Research Program

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Use of pulse echo impact hammer and transducer.

Nondestructive Testing of Foundation at Lock No. 2, Mississippi River

by
Michael S. Dahlquist
US Army Engineer District, St. Paul

The St. Paul District developed a nondestructive testing (NDT) program to locate voids beneath concrete lock structures, a drilling program to confirm the NDT results, and a grouting program to fill any voids or areas of unconsolidated material beneath the lock floor slab, miter gate sills, and lock wall monoliths.

The District's Lock Rehabilitation program began in the winter of 1986 when Lock No. 2 (near Hastings, Minnesota) was dewatered for major maintenance. During a prior dewatering of Lock No. 2, voids were located under the upstream riverward portion of the floor slab and were subsequently grouted. Knowing that voids had occurred in the past and that Locks No. 2 through 10 are founded on river sand which may be susceptible to movement, engineers were seeking a method to determine the integrity of the foundations that was both cost and time efficient. The timeliness of the investigation was important because the method chosen had to precede grouting operations, and the entire process had to be completed within a 60-day period.

The NDT program employed two testing methods: pulse echo and ground-penetrating radar. Two methods were specified because conditions in the dewatered lock chamber would be variable. Surface conditions ranged from snow, sand, and ice to standing water or slush to bare concrete. The concrete thickness varied also, from 18 inches in the slab to over 9 feet at the miter gate sills. Because of these wide variations, a single testing method might have been ineffective.

Test Methods

Pulse echo testing is based on the propagation of mechanical energy waves through a media and the reflection of these waves at density changes within the media. The energy is introduced to the test location by means of some type of hammer. If no internal density changes are encountered as the energy propagates through the material, the energy wave will strike the opposite side of the member, and a portion of the energy will be reflected; the remainder will continue through the media until another discontinuity or interface is encountered. The percentage of energy reflected at an interface is dependent on the relative acoustical density of the materials at the interface. If changes such as cracks, honeycomb, low-density material, voids or disruptions of the cement matrix around reinforcement are encountered, a reflection pattern unique to the type of discontinuity will be developed (Figure 1).

A piezoelectric transducer, usually located immediately adjacent to the impact hammer, receives the reflected mechanical energy and transforms it into electrical energy. This energy is then processed, computer enhanced, and presented on a storage cathode ray tube. The pattern of the reflected energy can then be analyzed.

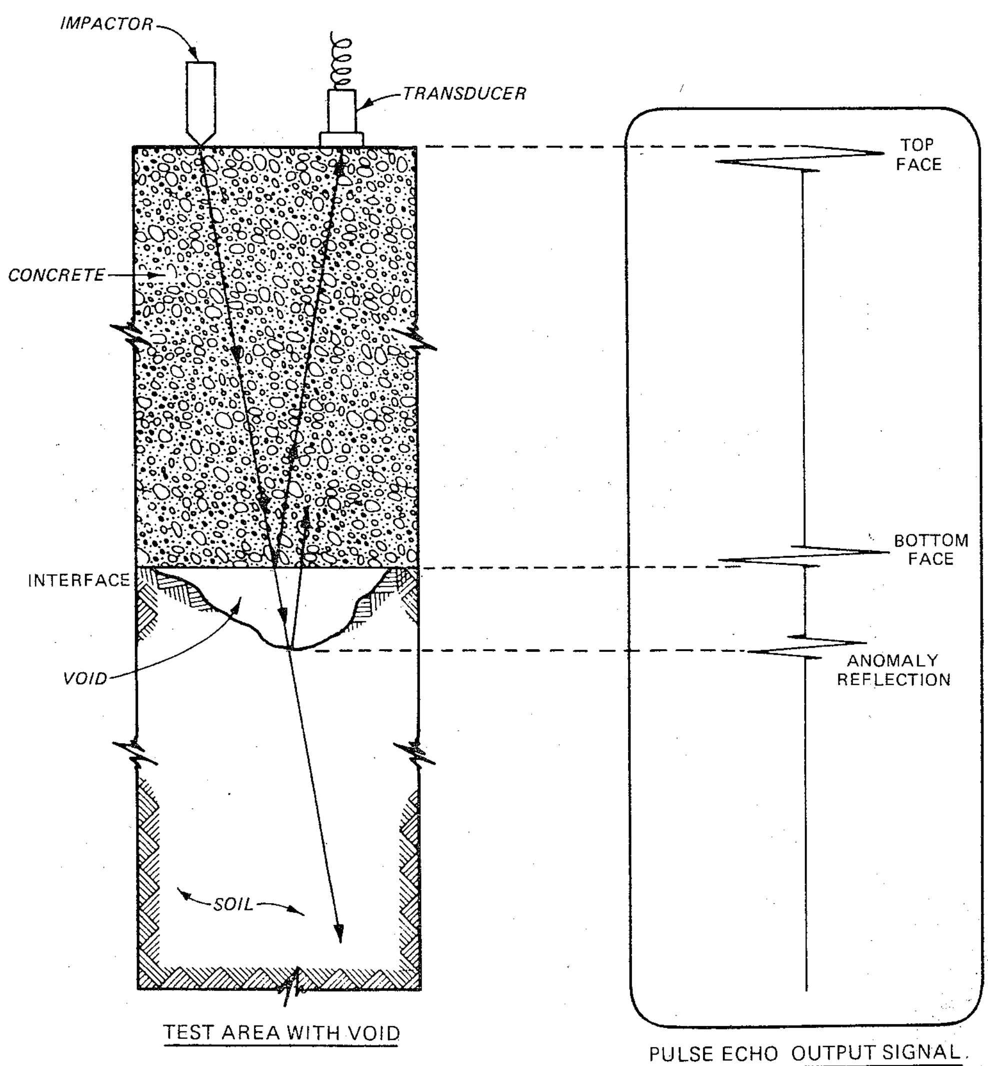


Figure 1. Pulse echo diagram.

Ground-penetrating radar is a geophysical tool which radiates repetitive short-time-duration electromagnetic pulses into materials from a broad bandwidth antenna/transducer. The equipment (Figure 2) functions as an echo sounding system able to measure the depth of reflecting discontinuities in materials. The amount of energy reflected back to the antenna is directly dependent on the dielectric constants of the materials encountered. In practice, continuous profiles are generated by towing a transducer over the area of interest while operating the system's graphic recorder. These profile records are immediately available for observation and interpretation, and survey methods can be adjusted as conditions dictate.

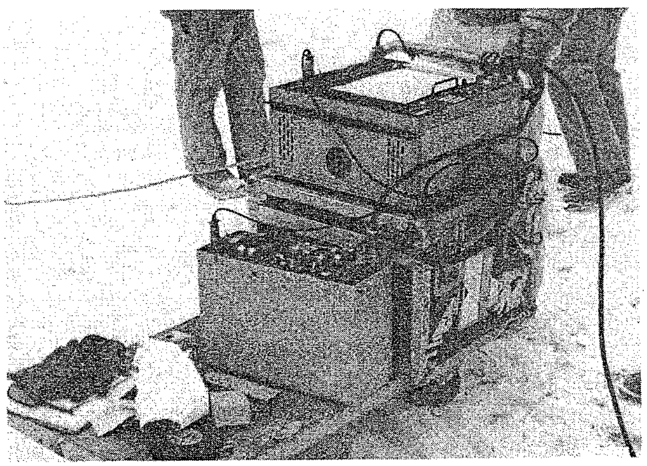


Figure 2. Radar equipment.

The range of the radar system is dependent on the frequency of the system and the conductivity of the material being probed. The conductivity is primarily dependent on the water content of the material and the amount of salts in solution. Under ideal conditions, the radar used at Lock No. 2 has a range of 30 to 40 feet; however, conditions in the lock chamber at the time of use reduced the effective range to less than 9 feet.

Most voids encountered under the lock structure were saturated with water, often frozen, and since the dielectric constants of ice or water, saturated sand, and concrete are similar, any anomalies located would be represented by subtle variations on the profile record. These subtle variations made careful interpretation of the output critical to successful application of radar in this environment.

Testing Program

The first phase of the foundation investigation consisted of a trial program in which both pulse echo and radar methods were employed in selected areas of the lock structure, including the floor slab, miter gate sills, and filling and emptying conduits. Also, varying degrees of surface preparation, such as leaving ice and snow or water on the lock floor or exposing bare concrete, were included in the trial program so both NDT methods could be tested under conditions that were likely to be encountered throughout the lock.

The trial program, which included drilling to physically verify the results of the NDT, provided much valuable information about the effectiveness of each test method under various conditions. Both methods were capable of performing the required testing in most areas of the lock; however, there were certain conditions under which each method was superior. For example, ground-penetrating radar is capable of covering large areas with minimal surface preparation in a short time. However, it is ineffective at locating voids where there is standing water or slush on the concrete surface, and highly trained personnel are required to interpret the data output. In comparison, the pulse echo method requires the test location to be free of ice and snow, but it can be used in water. The output is also much easier to interpret than that of the radar.

At the conclusion of the trial program, the NDT subcontractor, Richard Muenow, recommended, and the Corps agreed, that the full-scale testing program employ a combination of both methods. Pulse echo was used on the miter gate sills because of their thickness and in the area of the tainter valves because of the presence of standing water. Radar was used in the conduits because the concrete surface was coated with ice and the entire conduit could be examined with a single test line. Also, radar was used to test the floor slab because radar is fast and requires no costly surface preparation. However, in areas where radar testing produced questionable results or where surface conditions were unfavorable, the pulse echo method was used.

Results

As the testing progressed, areas of suspected voids were drilled and grouted. In general, the condition of the foundation material investigated was good. The presence of unconsolidated materials and voids from 1 to 6 inches in depth were scattered and isolated, making the probability of locating all voids by a drilling program alone quite low. As a measure of the testing program's effectiveness, the drilling and grouting contractor attempted to correlate the NDT results with the results of the drilling. Reported correlation was over 80 percent.

Temperature change was one factor that affected correlation and the use of pulse echo. The variable warming and cooling caused the ice to become soft and nonuniform, making the spring-loaded hammer used in the pulse echo method impractical because the plunger penetrated the ice surface. On hard, uniform ice, a striking plate could have been used for the pulse echo hammer and transducer.

The final step in the investigation was to drill several holes in areas where NDT had not indicated voiding. These areas were chosen by field engineers who were familiar with areas susceptible to voiding. A void was discovered in one of these areas. The NDT data were reevaluated; the conclusion was that conditions in the area made accurate interpretation of the data extremely difficult.

During the course of the project, refinement of the testing procedure and data interpretation increased the correlation between the NDT and the drilling programs. It became possible to distinguish between solid and soft materials as well as to identify voids at various levels.

Overall, the nondestructive testing program was successful in achieving the desired results. However, there is an opportunity for further refinement, and other options must be considered. A possible option includes allowing the contractor access to the lock chamber prior to dewatering so pulse echo could be used underwater, thus eliminating many surface irregularities or returning to a traditional grid-drilling program. In planning for the foundation investigation at Lock No. 3, the St. Paul District will consider the costs and benefits of the possible options before developing a plan.

For further information, contact Michael S. Dahlquist at the St. Paul District at 725-7628 (FTS) or (612) 725-7628.

Michael Dahlquist is a civil engineer in the Structural Design Section of the St. Paul District. On the Lock No. 2 project, he served as an assistant to the design project engineer, Gerald Cohen, and as construction engineer for the work done by the Corps' hired labor crew. He received his B.S. degree in civil engineering from the University of Minnesota, where he has also taken advanced work.

New Video Report on Plant Growth Regulators

A new video report, "Plant Growth Regulators and Grounds Maintenance," describes a 3-year field study conducted by the Natural Resources Research Program at the Waterways Experiment Station in Vicksburg, MS, to evaluate the potential of plant growth regulators in the maintenance of utility turf. Plant growth regulators, also known as growth retardants, are synthetic compounds which, when applied in small amounts, retard plant growth. Purposes of the study included determining whether use of plant growth regulators could significantly reduce cost and manpower requirements associated with mowing and trimming operations, assessing long-term effects of repeated applications, and providing guidance on repeated use of these compounds. Tests using different combinations of regulators and rates of application were conducted at six US locations, all of which have different climates, vegetation, and soil types.

Copies of the video report may be obtained from District and Division Natural Resources Management Branches through their Operations Divisions.

Chemical Grout Used to Stop Water Leakage in Control Towers and Conduits

by
Rick Lewis and Larry Brockman
US Army Engineer District, Louisville

District personnel at both the Buckhorn Lake Dam and the Barren River Lake Dam successfully eliminated water leakage in the control towers using a hand-operated pump (Alemite, model 7181) and TACSS-020 NF, a chemical grout manufactured by De Neef America, Inc. of St. Louis, Michigan. The grout is a hydrophobic polyurethane liquid that reacts with water to form a tough, rigid, closed-cell foam.

Barren River Lake Dam

Barren River Lake Dam, which was completed in 1964, is located in the Louisville District in south central Kentucky, 13 miles southwest of Glasgow. The project consists of an earthfill dam, a gate-controlled outlet works along the base of the left abutment, and an uncontrolled spillway through the right abutment. The dam embankment is 3,970 feet long, 146 feet high, and 30 feet wide at its top (elevation 618 feet). It consists of compacted impervious fill with a downstream random rockfill zone. The outlet works consists of a control tower (wet type) and three 6.5- by 14-foot hydraulically operated vertical slide gates, two 36-inch--diameter low-flow bypass pipes, four 4- by 4-foot multilevel inlets, a 17- by 17-foot semielliptical conduit, and a stilling basin. The spillway is 300 feet wide with a crest elevation of 590 feet.

During an inspection in March 1985, leakage was noted in the wet well of bypass valve number 2 of the control tower at elevations 512 and 523 feet. At each elevation, leakage was found coming from a single hole in an area of honeycombed or rotten concrete with no cracking evident around either of the holes. At that time, each hole was approximately 5/8 inch in diameter and 4 to 6 inches deep.

In December 1985 District personnel attempted to stop the leakage with FLEX 44, a chemical grout manufactured by De Neef America, Inc. A pneumatic-powered masonry drill with a 1/2-inch-diameter bit was used to drill a 6-inch-deep hole within 4 inches of the leaking hole at elevation 512 feet. During drilling, the rotten concrete gave way, creating an oversized hole; therefore, the recommended packer did not provide a watertight compressive seal. To prevent the premature mixing of the grout and water in the injection hose, a cutoff valve was installed at the injection port. In an attempt to reduce leakage around the injection port, rags were pressed tightly around the packer. However, the leakage was not stopped. Before the cutoff valve was opened, a slight amount of pressure was applied. Three gallons of FLEX 44 combined with 5 percent FLEXCAT accelerator was pumped into the port with a hand-operated, 500-pound-per-square-inch (psi) capacity, volume delivery bucket pump (Alemite, model 7181). The amount of leakage was too great, and the grout was flushed out before it could gel. The repair effort was terminated.

Remedial grouting was completed in March 1986. At the time of the repair, the lake was at elevation 526.1 feet, resulting in a hydrostatic head of 14.1 feet on the outside of the tower at elevation 512 feet and 3.1 feet at elevation 523 feet. Flow rates at these elevations were approximately 1 and 2 gallons per minute, respectively. The water temperature was 51 degrees Fahrenheit.

Repair work began at the leakage at elevation 512 feet. A 12-inch length of 1/2-inch copper tubing was inserted approximately 6 inches into the hole. Oakum was then packed around the tubing to divert most of the leakage through the tubing. Water Plug, a fast-setting hydraulic cement manufactured by Thoro Systems of Miami, Florida, was then kneaded into a fairly stiff ball and packed around the copper tubing three times before all of the leakage was diverted through the tubing (Figure 1). The

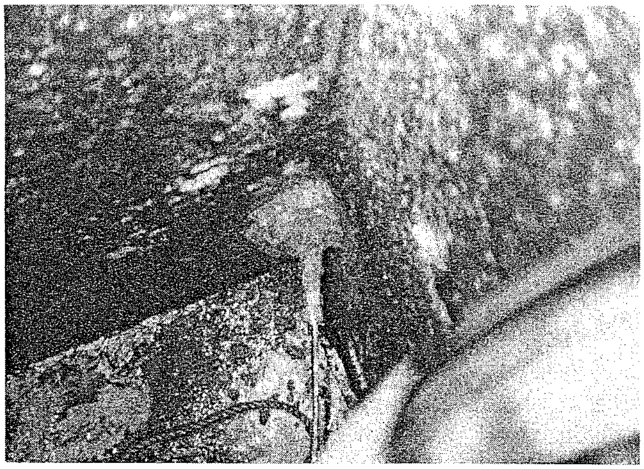


Figure 1. Injection port; copper tubing with valve installed in wall with oakum and hydraulic cement packed around the tubing; Barren River Lake.

cement cured for 45 minutes before grouting was begun.

Two gallons of TACSS-020 NF was mixed manually in the pump bucket with 10 percent C-852 accelerator to obtain a minimum gel time of 4 minutes 30 seconds at the given water temperature. To ensure that water did not enter the open end of the hose or the pump, the cutoff valve on the end of the copper tubing was closed before the pump hose was attached, and a small amount of pressure was applied before the valve was opened and the grout pumped into the void. Bubbles around the port indicated the grout was reacting. The valve was closed after approximately 10 to 15 minutes gel time and the hose was disconnected. After an hour, the tubing was cut off flush with the wall. No leakage was noted after repair.

At higher elevation (523 feet), the existing hole was drilled to a 12-inch depth. A 1/2-inch piece of copper tubing was inserted 6 inches into the hole and Water Plug was packed around the tubing. The leakage could not be totally diverted through the tubing. As the grout was pumped into the void, rags were used to apply pressure around the tubing, but this effort proved unsuccessful as most of the grout was washed out of the hole.

The tubing and Water Plug were removed, and the tubing was reinserted. Oakum packed around the tubing stopped the leakage, and the grouting operation was resumed. Approximately 2 gallons of grout was pumped into the void. The grout was allowed 10 to 15 minutes to gel before the pump hose was disconnected. After an hour, the tubing was cut off flush with the wall surface. No leakage was noted after the repair (Figure 2).

Figure 2. Repaired area at Barren River Lake.

Buckhorn Lake Dam

Buckhorn Lake Dam, completed in 1960, is located in southeastern Kentucky on the Middle Fork Kentucky River near Buckhorn in the Louisville District. The project consists of an earthfill dam, a controlled outlet works along the base of the abutment, and a variable-width, gate-controlled spillway through the right abutment. The dam embankment is 1,020 feet long, 160 feet high, and 30 feet wide at its top (elevation 877 feet). It consists of compacted random rock with a central impervious core. The spillway has a crest elevation of 820 feet with four 33- by 23-foot vertical lift gates providing total flood control storage to elevation 840 feet. The outlet works consists of a control tower (dry type) with three 5.5- by 11-foot hydraulically operated, vertical slide gates (invert elevation 724 feet), two 24-inch-diameter low-flow bypass pipes, a 14- by 14-foot semielliptical conduit, and a stilling basin.

In 1962, leakage was reported in the left wall of the conduit at monolith joint 2/3, approximately 40 feet downstream of the service gates. By 1980, leakage had increased enough to require routine monitoring. In 1981 District personnel attempted to stop the leakage with Water Plug. The rate of leakage at the time of the attempted repair was approximately 5 gallons per minute, too great to allow the Water Plug time to set before being washed out. The rate of flow continued to increase, reaching peaks of 15 to 20 gallons per minute in 1986.

The leakage at Buckhorn Lake Dam was eliminated in July 1986. Injection ports, consisting of a 1/2-inch copper tubing with a cutoff valve and a fitting to attach to the delivery hose, were fabricated by District personnel. Two holes, into which ports were installed, existed prior to this repair effort. One hole drilled in 1962 penetrated the waterstop approximately 15 inches into the concrete. The other hole, eroded by the flow of the water over the years, had increased to the point that the 1/2-inch copper tubing could be inserted 18 inches or more. Three 3/4-inch-diameter holes were drilled to relieve pressure during the sealing process. These holes were drilled to the depth of the waterstop, about 6 inches, but did not penetrate it.

Port tubings inserted near full depth of each hole provided a longer flow path, thereby increasing the time the grout had to set before exiting the concrete. Oakum packed into cracks and holes around the ports directed the majority of leakage through the ports. This process had to be done in a persistent manner, since pressure increased as each small quantity of flow was shut off. At times one closure would cause a previously sealed area to leak again. After the packing of the oakum was completed, the effectiveness of the packing was checked by closing all five valves. Preco Plug packed into the cracks around and over the oakum provided additional resistance against blowout (Figure 3).

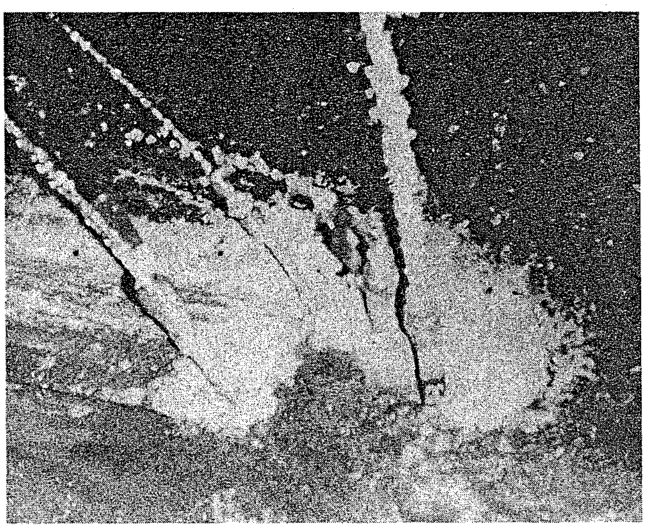


Figure 3. Close-up of four ports in monolith No. 2 with Preco Plug applied.

After the Preco Plug had set for about 20 minutes, 2-1/2 gallons of TACSS-020 NF mixed with 5 percent of C-852 accelerator was pumped through the open valve of the port occupying the eroded hole. A number of extremely small seeps that existed prior to the start of the grouting operation stopped after 2 to 3 minutes with grout solidifying on the interior wall at some of the seep locations. After all of the approximately 2-1/2 gallons of grout mix had been pumped, the port valve was closed to allow time for the grout to react and solidify (Figure 4). Another 2-1/2 gallons

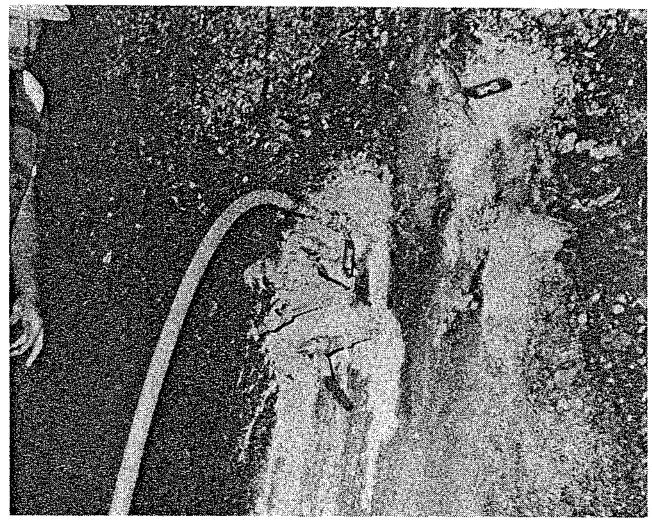


Figure 4. Allowing time for grout to gel prior to removal of injection hose; Buckhorn Lake.

of mix was prepared; pumping into the single downstream port was initiated, but no grout was taken. With valves closed and hose removed, the injected grout was allowed to gel for an additional 30 minutes. Ports were then cut off slightly below the wall surface and the projecting oakum was removed. Preco Plug was spread over the work area to form a protective seal (Figure 5).

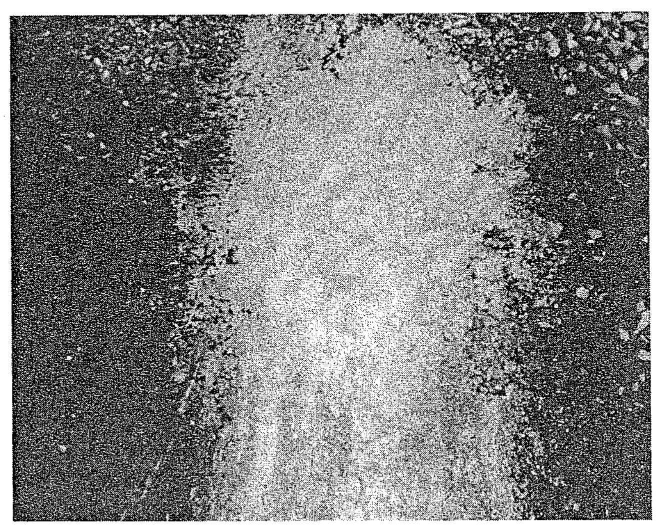


Figure 5. Preco Plug seal; Buckhorn Lake.

The work was inspected after about 2 years of normal discharge operation with no leakage noted.

Costs

The estimated cost of the repairs was as follows (time and travel expenses incurred by Engineering not included):

Barren River Lake Dam

Material	$400.00
Pump	200.00
Labor	800.00
Total	$1,400.00

Buckhorn Lake Dam

Material	$500.00
Pump	200.00
Labor	1,500.00
Total	$2,200.00

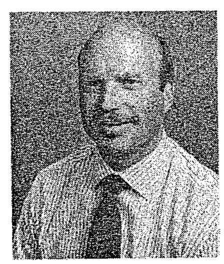
Summary

In 1986, District personnel at both the Buckhorn Lake Dam and the Barren River Lake Dam were successful in stopping water leakage at their respective projects. The general procedure followed in both repair operations included:

- Drilling a hole or holes into the point of leakage.
- Installing copper tubing in the holes to serve as injection ports for the grout. (A cutoff valve should be installed on the tubing to stop the leakage just before connecting the pump.)
- Packing the area around the tubing with oakum.
- Sealing the area around the copper tubing with hydraulic cement (if required).
- Pumping the TACSS-020 NF into the opening.
- Allowing sufficient gel time before chiseling the ports off flush with the surface of the concrete.
- Coating the surface with a quick setting hydraulic cement to provide protection of the repaired area.

For further information about the repairs, contact Rick Lewis at 352-5600 (FTS) or Larry Brockman at 352-5137 (FTS).

Larry Brockman is currently Chief of the Instrumentation and Surveillance Section in the Louisville District's Geotechnical Branch. He came to the District in 1976 as Chief of the Structural Section. His work as a Civil/Structural Engineer also includes ten years in the Omaha District and five years in the Bureau of Reclamation's Design Office. He received his B.S. degree in civil engineering from New Mexico State University.



Rick Lewis has been Project Engineer in the Maintenance Engineering Branch, Operations Division, Louisville District, for the past four and a half years. Before that he spent five years as Project Engineer and Quality Control Engineer at the TVA Hartsville Nuclear Plant during its construction. Rick earned his B.S. degree in civil engineering at Tennessee Technological University.

Request for Articles

If you have experience in any of the areas being addressed by the REMR Research Program, *The REMR Bulletin* is actively soliciting articles. Articles by individuals outside the Corps will be considered if relevant to REMR activities of the Corps.

To submit an article, write to: Commander and Director, US Army Engineer Waterways Experiment Station, ATTN: CEWES-SC-A, PO Box 631, Vicksburg, MS 39180-0631.

When submitting photographs with articles, please provide glossy prints or film rather than prescreened negatives.

Chemical and Asphaltic Grouts for Sealing Coastal Structures to Sand Infiltration and Wave Transmission

by
David P. Simpson
US Army Engineer Waterways Experiment Station

Worldwide competition among ports and shippers has accentuated the need for Federal waterways projects to maximize navigability and minimize operations and maintenance expenditures. Clearly, the objective of the Corps should be to make coastal navigation structures as effective as possible.

Shoaling and unacceptable wave heights are two problems caused by a structure's permeability. Sediment which moves through a jetty and appears on the lee side usually forms a shoal. Cutting off the sediment flow may be important because, although volumetrically small, the shoal may reduce navigability of the project and require frequent dredging. In an area protected by a breakwater, surge arising from wave transmission through the structure may have critical economic consequences.

Injecting grout into coastal structures apparently reduces sediment flow and wave transmission through those structures (Figure 1). The idea holds potential for economically reducing shoaling in local areas and increasing a structure's performance in blocking wave energy. For general channel shoaling, the savings in dredging volume alone could justify a grouting program. Guidance to field offices is needed so that successful grouting operations may be carried out.

Grouting, as developed in the field of civil and mining engineering, took the form of structural grouting (for foundation stabilization, tunneling, and rock bolting) and waterproof grouting (for control of uplift pressures and seepage). Grouts having very specific injectability and strength characteristics, as well as set times and durability, have been developed for those purposes. Typical applications in coastal engineering do not require the grout to impart strength or watertight characteristics to the material into which the grout is injected. Instead, grouts must fill large voids between jetty stones in the structure's interior and stabilize sand that may fill the voids. Grouts must be easily pumped and injected, difficult to dilute and erode when placed in flowing water, and safe in the environment. They must have a controllable set time and a long service life.

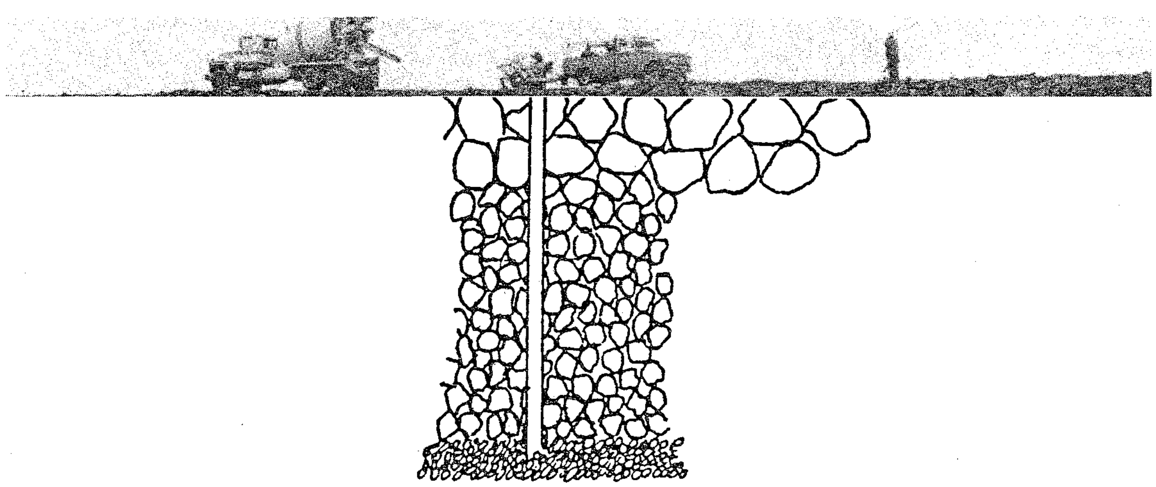


Figure 1. Concept of pressure grouting the core of a rubble-mound structure.

Chemical grouts which show promise in coastal applications are a mixture of portland cement and sodium silicate solutions, and for grouting sandy material, a sodium silicate solution with a chemical reactant seems best. A sanded cement mixture that has been effective consists of coarse aggregate for filler, clay for improved pumpability, and calcium chloride as an accelerator.

Asphaltic concretes are under consideration also. The material is chemically inert; it relies on physical bonding to produce a firm mass. Hot asphalt is mixed in various proportions with coarse aggregate and/or sand and mineral filler to produce materials that have a variety of rheological and permeable characteristics.

In 1985 the south jetty of the Palm Beach Harbor, Florida, project was grouted to eliminate a shoal that progressed channelward from the south jetty and interfered with navigation (Figure 2). A grout curtain 800 feet long, 6 feet thick, and extending in height from -10 feet mean low water to the jetty crest was created. In estimating the quantity of grout needed, planners assumed 30 percent of the space to be grouted was void volume. Experimentation with various grout compositions and hole spacing revealed the best grout mixture to be 1 cubic foot of cement to 10 cubic feet of sodium silicate to 9.5 cubic feet of water. An accelerator was not needed because of the action of the salts in the ocean water that saturated the sand into which the grout was injected. Injection was through 2-1/2-inch drill casings. Final hole spacing was 3 feet center-to-center; the pattern of hole locations was linear. A better buildup of grout was obtained by staging the grout in an alternate-hole sequence. The grout take was from 2 to 4 gallons per minute for 10-minute durations with each vertical foot of the injector location.

The San Francisco District sealed the Buhne Point, California, groins for a total distance of 1,200 feet in 1985. All treatment was done on groin centerlines in two phases. In the first phase holes were drilled and grouted on 10-foot centers. The second phase placed holes midway between the holes of the first phase. This procedure was repeated until, in some areas, grout holes were on 2-1/2-foot centers. Hole diameter was 4 inches and depth was 14-1/2 feet. One cubic yard of sealant was composed of coarse aggregate, 1,115 pounds; fine aggregate, 1,655 pounds; cement, 705 pounds; clay, 37 pounds; water, 371 pounds; and calcium chloride, 15 pounds. The mixture had a 5-inch slump. The sealant take in holes drilled on 10-foot centers was 7 cubic yards per hole. Holes of the phase two drilling took sealant at 5 cubic yards per hole. The final holes, placed 2-1/2 feet from adjacent holes, had a take of 1 cubic yard per hole.

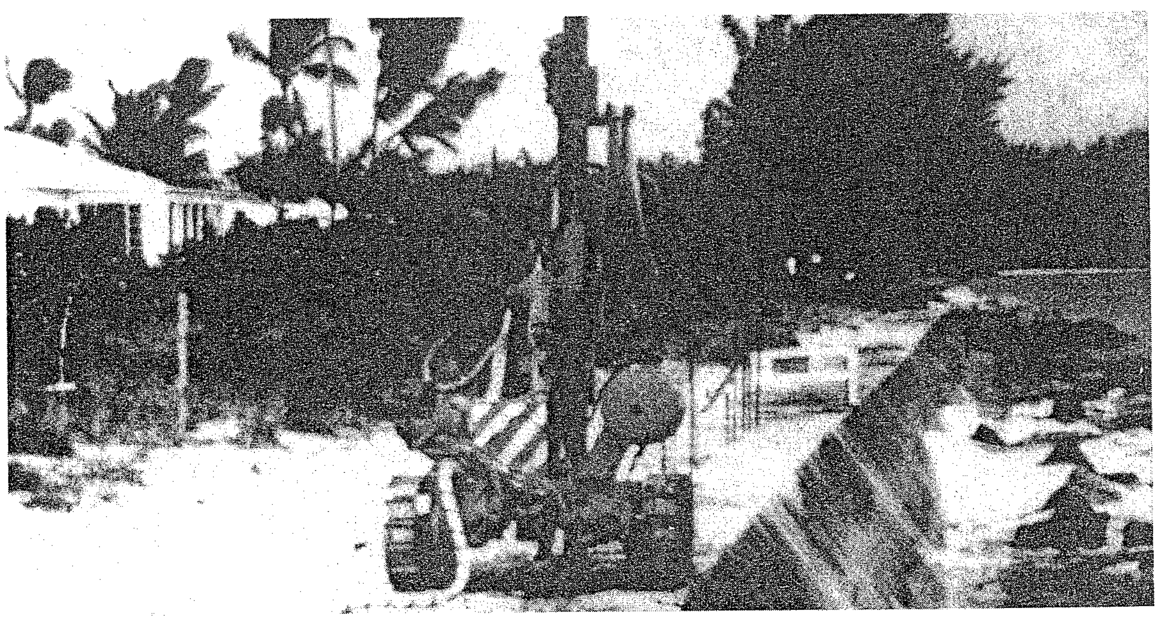


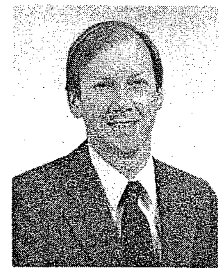
Figure 2. Drill rig atop Palm Beach Harbor South Jetty. Grout injectors were installed as the rig advanced in preparation of grouting operations.

Research in FY87 has focused on:

- Testing injectability and durability of sealants having various mixture designs
- Evaluating effectiveness of various injection techniques.
- Evaluating durability of sealants in the prototype environment.
- Designing a field evaluation program of grouting effectiveness.

Readers who know of any other type of grout application to coastal structures are requested to contact the coprincipal investigator of the work unit, Dr. Lyndall Hales, at 542-3207 (FTS) or (601) 634-3207 or Jeff Thomas at 542-2089 (FTS) or (601) 634-2089.

David Simpson is a hydraulic engineer in the Research Division of the Coastal Engineering Research Center, Waterways Experiment Station, and is currently a coprincipal investigator for REMR Work Unit 32375, "Void Sealing of Permeable Jetties and Breakwaters." He received his B.S. degree in oceanography and ecology and an M.S. degree in ocean engineering from the University of Washington. He is currently taking advanced courses at the University of Florida under Department of the Army long-term training.



REMR News

Mohan Singh is the new Technical Area Monitor for the Electrical and Mechanical problem area. He replaces Bob Kinsel, who served in that capacity since the inception of the REMR Research Program.

Bruce McCartney has left Corps Headquarters in Washington to return to the North Pacific Division where he will be working in the Engineering Division. He has served as a member of the REMR Overview Committee since the inception of the REMR Research Program, and we will miss his able guidance in that capacity. Many thanks to Bruce for his efforts and support.

The REMR Bulletin Distribution

In order to keep the distribution list for *The REMR Bulletin* up to date, we need input from our readers. Some copies may not be going to the proper addresses, and some copies may be going to people who do not want to receive them. A still greater problem would be that readers who do want *The REMR Bulletin* do not know how to receive a copy. If you have a change of address or know of someone who would like to receive *The REMR Bulletin,* please write to: Commander and Director, US Army Engineer Waterways Experiment Station, ATTN: Bobby Baylot (CEWES-SC-A), PO Box 631, Vicksburg, MS 39180-0631.

COVER PHOTOS

Drilling and concrete grouting; Buhne Point Shoreline Demonstration Project in Humboldt Bay, California.

Towing radar antenna over test site.

The REMR *Bulletin*

The REMR Bulletin is published in accordance with AR 310-2 as one of the information exchange functions of the Corps of Engineers. It is primarily intended to be a forum whereby information on repair, evaluation, maintenance, and rehabilitation work done or managed by Corps field offices can be rapidly and widely disseminated to other Corps offices, other US Government agencies, and the engineering community in general. Contributions of articles, news, reviews, notices, and other pertinent types of information are solicited from all sources and will be considered for publication so long as they are relevant to REMR activities. Special consideration will be given to reports of Corps field experience in repair and maintenance of civil works projects. In considering the application of technology described herein, the reader should note that the purpose of *The REMR Bulletin* is information exchange and not the promulgation of Corps policy; thus, guidance on recommended practice in any given area should be sought through appropriate channels or in other documents. The contents of this bulletin are not to be used for advertising, publication, or promotional purposes. Citation of trade names does not constitute an official endorsement or approval of the use of such commercial products. *The REMR Bulletin* will be issued on an irregular basis as dictated by the quantity and importance of information available for dissemination. Communications are welcomed and should be made by writing the Commander and Director, US Army Engineer Waterways Experiment Station, ATTN: Bobby Baylot (CEWES-SC-A), PO Box 631, Vicksburg, MS 39180-0631, or calling 601-634-2587 (FTS 542-2587).

DWAYNE G. LEE
Colonel, Corps of Engineers
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